A Comparison of Reclaimed Strip Mine Soils Under Old and New Laws in Ohio

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Introduction

Recently many articles and publications have been written about the adverse affects of strip mining in the United States. A large majority of these articles seemed to employ scare tactics and it became difficult to seperate the facts from yellow journalism. Many authors recommended abolishment of strip mining, because of its impact on the environment, while others sought stricter controls. Since a large percentage of the electrical power in Ohio is generated by coal, the abolishment of strip mining seemed impractical and even stricter controls would cause cost increases.

After the author became interested in these problems, he sought the help of Mr. Vernon Gerst of the Marietta Coal Company, and Dr. F. L. Himes of the Agronomy Department at Ohio State University. Through the assistance of Mr. Gerst and Dr. Himes, the author collected and analized soil samples from mines covered under the old and new laws in Belmont and Noble Counties, Ohio.

The purpose of this investigation was to compare the effectiveness of reclamation under the new law with that of the old law and to see if further controls are necessary.

Abstract

Belmont and Noble Counties, Ohio, have been strip mined since the early part of the century with very few restricitions as to reclamation and mining operations. The Ohio legislature enacted a new strip mine law, which went into effect on April 10, 1972. Under this law, mining operations and reclamation of affected land are carefully controlled. Guidlines and procedures were developed to control runoff and to restore the land, as nearly as possible, to its original condition.

Soil samples from three mining areas, two reclaimed under old law and one under the new law, were collected and analized in order to evaluate the effectiveness of new law regulations.

Mining History and Methods

Strip mining is a process used in the extraction of coal from natural deposits by removing all of the overlaying material. This process is the most effective of all mining methods as it removes nearly 100 percent of the coal. It is widely used in Southeastern Ohio because of the relative ease in removing the over-burden and exposing the coal.

Under old law mining procedures, the mining operation began with a bulldozer shoving all of the foliage into surrounding ravines. The overburden was then removed, with no attempt made to save the topsoil or subsoil. The overburden was merely moved aside in the least expensive manner in order to expose the under-lying coal. The coal was then removed and hauled away. High walls are left standing. In some cases, attempt was made to smooth the surface of the spoil material resulting in a plateau affect with towering highwalls. The area was then reseeded with trees or grasses. However, due to the manner in which the spoil was replaced, little or no fertile soil material remained on the surface. In addition, many nitrogen and sulfur containing materials were left on or near the surface. These materials tend to oxidize producing acids that greatly lower the PH of the soil material. Consequently very little vegetation survives in these areas and the reclaimed lands become deeply eroded and barren.

Under the new law an area is first surveyed in order to establish the configuration of the land surface and the exact area to be stripped. Bonds are deposited to insure that no damage is done to surrounding region and that the mined area is replaced according to established regulations. Trees are then removed and either sold or stockpiled to b buried in the new pit. The overburden is then removed with special care being taken to save the topsoils and subsoils for reclamation. The operator must begin the process of reclamation within three months after the overburden has been removed. This time limit aids in preventing environmental damage, which was caused in the past by the leaving of open pits for months or even years before beginning reclamation. Within this three month time limit, the operator must begin all reclamation work, except planting, which includes backfilling, grading, and resoiling with a layer of the original topsoil. Planting must be done no later than the next appropriate season for that type of planting after the other reclamation work is completed. Sediment ponds are constructed in drainage ways to allow the sediments in the runoff water to settle in order to prevent siltation in streams and lakes. Following completion of reclamation, the area is inspected and, if it meets the requirements of the new law, one half of the bonds deposited by the coal company are refunded. One year later the area is again inspected and if satisfactory the remainder of bonds are returned.

Failure to meet the standards set for the reclaimed land and for the quality of the water draining from the affected areas results in stiff fines and forfeiture of bonds or other penalties as described in the new law.

Description of Areas Investigated

Samples A-1 through A-40 were taken from pits in the Batesville area in Noble County, Ohio. The mines were reclaimed in 1971 and 1972 under the old law requirements. The mines were planted mainly with black locust, red oak, red maples, sycamore, and green ash. Some areas were seeded with grasses. Over all the vegetation growth is poor and extremely spotty with large variations in growth occuring within a few feet. These variations are evidence of the drastic changes in soil chemistry in areas reclaimed under the old law. The overburden in this area was mainly sandstone and shale and the soils belong to the Westmore-Guernsey Association. The coal mined was the Meigs Creek #9 with a sulfur content of 4.5-5%.

Samples B-1 through B-50 were taken from the Banfield Road pit near St. Clairsville in Belmont County, Ohio. This area was reclaimed under the old law by the Marietta Coal Company. Even though not required by law at this time, topsoil was placed on the area producing a greatly different soil chemistry than area A, and also the vegetation on B is a good uniform grass cover as compared to the more barren area A. The overburden in this, area consists of both limy and non-limy shale interbedded with siltstone and small amounts of dolomitic limestone. Soils belong to the Guernsey-Westmore-Westmoreland Associations. The coal mined was the Waynesburg No. 11 seam, which has a sulfur content of 1.5 to 2%.

Samples C-1 through C-107 were taken from the Barton Road pit and the Roscoe pit which are also near St. Clairsville, Ohio. This area was reclaimed under the 1972 law. The highwalls forming the prodominate features in the other areas are absent here, and the vegetative cover consists of a very good growth of wheat that acts as a cover crop, with grasses following. Here the overburden and the soil association is the same as area B.

Investigative Procedures

Soil samples were collected in three strip-mining areas. The samples were taken from the top three inches of soil material by means of soil probes and spades. The samples were then analyzed for pH, lime index, available phosphorpus, and exchangable potassium.

The method used to determine pH was to mix equal volumes of soil and distilled water, in this case one teaspoon of each, in a small cup, allowing it to stand for 10 minutes, and then read the pH on a pH meter.

To find the lime index the same techinque as above was used except a buffer solution was substituted for distilled water.

To find the amount of available phosphorous the Purdue Soil Test Kit procedure was used. In this method 10ml of Phosphate Reagent No. 1 is added to a test tube, with one-half teaspoon of soil. The mixture is shaken vigorously for 10 minutes, and filtered. At least 5 ml of this solution is added to a small amount of Phosphate Reagent No. 2, mixed and compared with a phosphate color chart. More Phosphate Reagent No. 2 is added and if a more intense color is produced, the latter reading is used.

Two methods were used to determine the amount of exchangeable potassium. The first method was by means of the Purdue Soil Test Kit. In this procedure, to 10ml of Potassium Reapent No. 1 in a test tube are added one teaspoon of soil. The mixture is shaken for one minute and filtered. To exactly 5 ml of filtered solution are added 2.5 ml of Potassium Reagent No. 2, the mixture is shaken and after three minutes the turbidity of the solution is compared with the standard on the Potassium Chart. The second method used was the flame spectrophotmetric method. In this technique 10 g of dry soil are placed in a 125 ml flask to which are added 50 ml of NH_4OAc. The mixture is shaken for 10 minutes and the filtrate collected, the same step is repeated again using distilled water. The combined filtrates are diluted to 250 ml with distilled water, and 20 ml of this solution are taken and the potassium concentration is determined with a flame photometer.

DATA
OLD LAW - STRIP MINE (A)
AGE 2 YEARS

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
A - 1	3.3	38	high	very low
A - 2	3.5			
A - 3	3.7			
A - 4	4.9			
A - 5	4.0			
A-- 6	4.2	42		
A - 7	4.5			
A - 8	3.5			
A - 9	3.2	31	high	very low
A - 10	3.2	30		
A - 11	3.5			
A - 12	3.5			
A - 13	3.6			
A - 14	6.4			
A - 15	7.1	73	medium	high
A - 16	4.6			
A - 17	3.5			
A - 18	3.7			
A - 19	5.7	56	high	high
A - 20	4.0			
A - 21	6.1			
A - 22	6.6	73		
A - 23	4.2			
A - 24	4.6			
A - 25	3.3			

con't DATA STRIP MINE (A)

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
A - 26	3.6			
A - 27	4.2			
A - 28	4.1	43	very high	very low
A - 29	3.5	39		
A - 30	3.8			
A - 31	4.4			
A - 32	3.7	39		
A - 33	4.8	51	very low	low
A - 34	4.2	44		
A - 35	3.7			
A - 36	4.2			
A - 37	4.0			
A - 38	5.2	46	very low	very low
A - 39	3.8			
A - 40	3.6			
Average	3.99	46	high	low

DATA
OLD LAW - STRIP MINE (B)
Age 2 YEARS

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
B - 1	6.1			
B - 2	6.6			
B - 3	6.3			
B - 4	6.2			
B - 5	5.9			
B - 6	4.3	40	very high	medium
B - 7	6.3			
B - 8	6.2			
B - 9	5.2			
B - 10	5.8			
B - 11	5.2			
B - 12	4.2			
B - 13	5.6			
B - 14	4.7			
B - 15	6.4			
B - 16	6.2			
B - 17	6.4			
B - 18	6.4			
B - 19	4.2	54		
B - 20	4.5			
B - 21	4.5			
B - 22	6.0			
B - 23	6.3			
B - 24	5.8			
B - 25	6.0			

Con't DATA STRIP MINE (B)

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
B - 26	4.0	51		
B - 27	3.3			
B - 28	5.6			
B - 29	5.8			
B - 30	5.5	44		
B - 31	3.8			
B - 32	5.9			
B - 33	6.3			
B - 34	6.4			
B - 35	6.2			
B - 36	4.9	66	very high	medium
B - 37	5.5	69		
B - 38	6.0			
B - 39	3.8	45		
B - 40	5.7			
B - 41	4.9			
B - 42	6.0			
B - 43	3.5	47	high	medium
B - 44	5.8			
B - 45	6.2	72		
B - 46	3.7			
B - 47	6.0			
B - 48	6.1			
B - 49	6.0			
B - 50	6.3	72	very high	medium

contt DATA STRIP MINE (B)

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
Average	5.56	56	very high	medium

DATA
OLD LAW - STRIP MINE (C)
AGE 1 YEAR

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
C - 1	6.0			
C - 2	6.0			
C - 3	5.8	64	medium	high
C - 4	5.5	61		
C - 5	5.7			
C - 6	5.8			
C - 7	4.8			
C - 8	5.2			
C - 9	5.3			
C - 10	5.5	64	low	medium
C - 11	5.8	68		
C - 12	5.3			
C - 13	5.3			
C - 14	4.6			
C - 15	5.2			
C - 16	5.8			
C - 17	5.6			
C - 18	5.3			
C - 19	5.1			
C - 20	5.2			
C - 21	5.9			
C - 22	6.4			
C - 23	5.6			
C - 24	5.3			
C - 25	5.4			

con't DATA STRIP MINE (C)

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
C - 26	5.7			
C - 27	5.8			
C - 28	6.0			
C - 29	5.5			
C - 30	5.8			
C - 31	5.7	64	low	medium
C - 32	6.0			
C - 33	5.5			
C - 34	5.6			
C - 35	5.7			
C - 36	5.6			
C - 37	5.6			
C - 38	5.9			
C - 39	5.2			
C - 40	5.3	58	low	low
C - 41	5.0			
C - 42	5.4			
C - 43	5.4			
C - 44	5.2			
C - 45	5.0			
C - 46	5.1			
C - 47	6.0			
C - 48	6.3	69	medium	medium
C - 49	5.7			
C - 50	5.8			

con't DATA STRIP MINE (C)

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
C - 51	5.3			
C - 52	5.3	60		
C - 53	5.3	53		
C - 54	5.5			
C - 55	5.3	61		
C - 56	5.8			
C - 57	5.9			
C - 58	6.2			
C - 59	5.8			
C - 60	5.7			
C - 61	6.0			
C - 62	6.1			
C - 63	5.0			
C - 64	5.8	65		
C - 65	5.5			
C - 66	5.6			
C - 67	6.0			
C - 68	5.7			
C - 69	6.4	69	low	very low
C - 70	5.5			
C - 71	5.6			
C - 72	5.7	64		
C - 73	5.1			
C - 74	5.0	53	medium	high
C - 75	5.5			

con't DATA STRIP MINE (C)

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
C - 76	5.6			
C - 77	5.5			
C - 78	5.5			
C - 79	4.8			
C - 80	5.5	65		
C - 81	5.0			
C - 82	6.4			
C - 83	5.2			
C - 84	5.1			
C - 85	5.1			
C - 86	5.4	64		
C - 87	5.0			
C - 88	5.3			
C - 89	5.2			
C - 90	5.5			
C - 91	5.5	64		
C - 92	7.2	72	very high	medium
C - 93	5.7			
C - 94	5.9			
C - 95	5.1			
C - 96	6.3			
C - 97	5.0			
C - 98	6.8	70		
C - 99	5.4			
C - 100	5.4			

con't DATA STRIP MINE (C)

Soil Sample #	pH	Lime Index	Available Phosphorous	Exchangeable Potassium
C - 101	5.9			
C - 102	6.6			
C - 103	5.3			
C - 104	5.1			
C - 105	5.0			
C - 106	5.3	57		
C - 107	4.9	53	medium	medium
Average	5.5	63	medium	medium

INTERPRETATION of DATA

The data show that the only major difference in the soil chemistry of the three areas was the pH. The amounts of potassium and phosphorous were about the same in each area. The extremely low pH in area A was due to the replacement of spoil material without topsoil or some other material on it to retard oxidation of acid forming materials. This low pH caused toxic concentrations of heavy metals, mainly Al and Mg, making plant growth very poor and in places impossible. This shows that the most important part of reclamation is the replacement of topsoil. Without this it is not possible to produce a successful vegetation cover and without this cover to retard erosion, severe siltation problems occur.

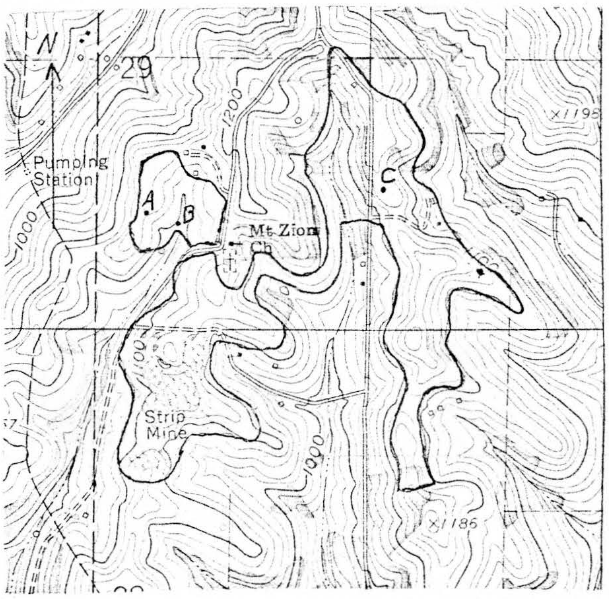

Figure 1: Map of area A from Quaker City Quadrangle.

In this area reclamation was completed under the old laws, consequently , no topsoil was replaced. Forty soil samples and three water samples were taken from throughout the area. The soil samples had an average pH of 3.99, a lime index of 46, high available phosphorous, and low exchangeable potassium. Site A was a low spot on the spoil, which was filled with water. The water had a pH of 2.35 and an iron content of 25.5 ppm. Site B was a small pond(figure 7) which had a pH of 2.87 and an iron content of 8.0 ppm. Site C is another low spot in the spoil that contains water throughout the year. The water had a pH of 3.05 and an iron content of 1.4 ppm.

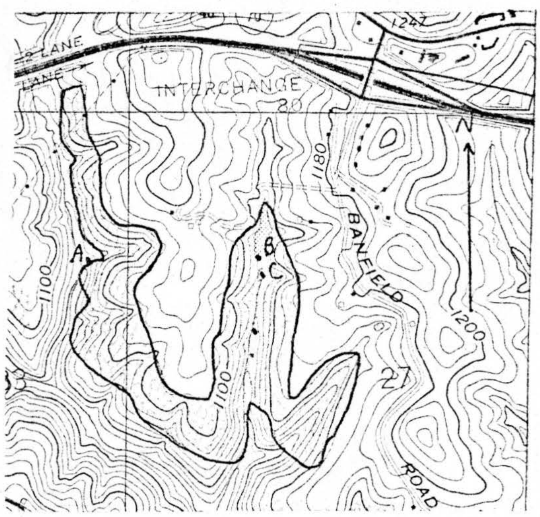

Figure 2: Partial map of area B from Lansing Quadrangle.

This area was reclaimed under the old law, but topsoil was replaced. Fifty soil samples and three water samples were taken from throughout the area. The soil samples had an average pH of 5.56, a lime index of 56, very high available phosphorous, and .11 meq/100g of soil of exchangeable potassium. The water at site A had a pH of 5.90 and an iron content of .09 ppm. At site B it had a pH of 7.50 and an iron content of .05 ppm. Water from C had a pH of 6.51 and an iron content of .01 ppm.

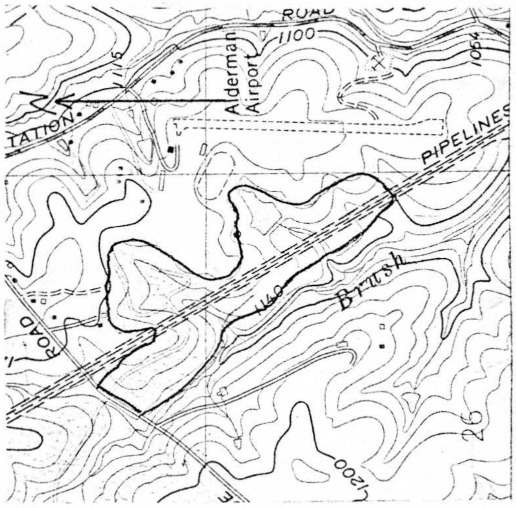

Figure 3: St. Clairsville Quadrangle, partial map of area C.

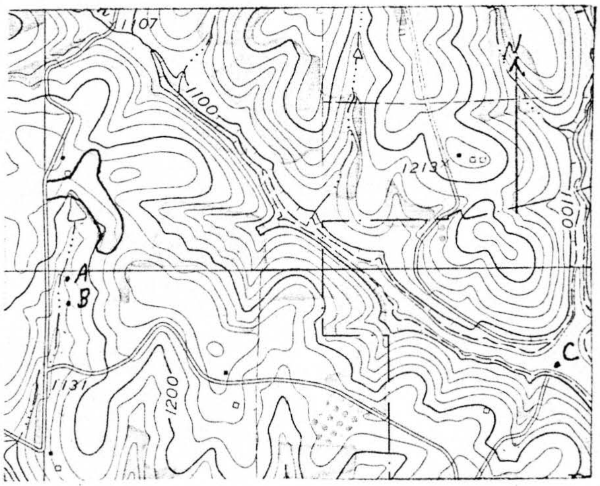

Figure 4: Partial map of area C from Bethesda Quadrangle.

These areas were reclaimed under the new law. A total of 107 soil and three water samples were taken from the two areas. The soil samples had an average pH of 5.5, a lime index of 63, medium available phosphorous, and medium exchangeable potassium. Sites A and B were sediment ponds constructed in the stream draining the area mined. At site A the pH was 6.55 and iron was .2.1 ppm. At site B (the lower of the two ponds) the pH was 6.71 and iron was .024 ppm. The water sample from site C was collected from Belmont Lake in order to determine if mining in the area has any affect on the lake. The water had a pH of 6.62 and an iron content of 0.0 ppm. These tests indicate that mining has had no apparent affect on the quality of the water in the lake.

Figure 5: Small pond in a reclaimed area(site C, figure 1).

Figure 6: Different view of pond in figure 5.

Figures 5 and 6 is a small pond representing point C in figure 1. This photograph was taken one year after the area had been reclaimed under the old law. The pond is a low spot in the spoil material and therefore does not drain into any stream, but it contains water all year. This area was planted with grasses and black locus trees. As can be seen, their growth was not good. Ten soil samples were taken within the area of figure 5, and the average pH of the soil was 3.99. The pH of the water was 3.05 and the iron content was 1.40 ppm.

Figure 7: Small impondment in a reclaimed area(site B, figure 1)

This photograph was taken in the area of figure 1. The pond is represented as site B, while site A is to the right of the pond, just beyond the edge of the picture. Eleven soil samples were taken from this area and the average pH of the soil was 3.5. The water in the pond had a pH of 2.87 and an iron content of 8.0 ppm. The other water sample taken in the low spot to the right of the pond had a pH of 2.35 and an iron content of 25.5 ppm.

Figure 8: Area adjacent to impondment.

This picture is of an area immediately adjacent to figure 6. The photograph was taken two years after reclamation. As can be seen in figures 6 and 8, some of the vegetation is growing, but it is very spotty and is too sparse to have much affect on erosion.

Figure 9: View of a reclaimed area.

Figure 9 represents the same area shown in figure 8, note vegetation growth and also how the spoil was merely leveled and the highwalls left unaltered.

Figure 10: Area reclaimed under the old law.

Figure 11: Area reclaimed under the old law.

Figures 10 and 11 represent areas reclaimed under the old law and show that the areas were simply leveled and abandoned. The highwalls are left standing untouched and , due to the lack of any topsoil, there is no vegetation cover and therefore the area resembles a desert. The complete lack of any vegetation, as in figure 11, greatly increases the rate of erosion. The tremendous increase in the amounts of sediment carried by the streams draining these areas can cause extensive damage, as is evident in the following figures.

Figure 12: Damage due to siltation.

Figure 13: Damage due to siltation.

Figure 14: Damage due to siltation.

Figure 15: Damage due to siltation.

Figure 16: Damage due to siltation.

Figures 12 - 16 were taken in Meigs County, Ohio, in order to show the damage caused by siltation, which results from the lack of vegetation on old mined areas. These areas in Meigs County were mined between 10 and 20 years ago. Figure 12 is an area immediately adjacent to a spoil pile, and the sediment in the foreground was derived from the spoil material in the background. Figure 13 was taken a short distance down stream from Figure 12 and shows how the sediment affects other areas as it moves downstream. Figure 14 was taken of a different stream but in the same area. The source of the sediments was an old mine in the center background of the picture. There was a great deal of damage done here because the farm in the picture was completely divided by the stream. The stream, which wasnot very large, could easily be crossed to gain access to that part of the farm on the other side. After the stream began dumping large amounts of sediment, it began to widen and now there is a strip of sand almost 200 feet wide and 10 feet deep through the middle of the farm. Not only is much of the land now covered by sand, which is not productive, but it is impossible to transport machinery across the stream, except during the driest part of the year. The land owner had at the time of the actual mining in the area, refused to sell any of his land for mining purposes. However his neighbors upstream did, and the result was extensive damage to his farm. He could do nothing about these effects because of the weak mining laws of the time, and the company that stripped the land is now out of buisness. Figures 15 and 16 were taken of the same stream that is shown in figure 14, only farther downstream in order to show the continuous streamside damage.

Figure 17: Area exhibiting scenic value of old law strip mines.

Figure 18: Area exhibiting scenic value of old law strip mines.

Figure 19: Figure exhibiting scenic value of old law strip mines.

Figure 20: Area exhibiting scenic value of old law strip mines.

Figures 17, 18, 19, and 20 were also taken in Meigs County, mainly to show the unsightlyness of old mines. These areas were simply stripped and abandoned. They are completely barren, there is no vegetation even after 20 years, except around the edges of the mine where the topsoil was not disturbed. Mines such as these cause the major problems associated with mine pollution— the acid drainage and siltation of streams.

Figure 21: Abandon shovel in area in figure 1.

Figure 22: Abandon dragline in area in figure 1.

Figures 21 and 22 were taken in Noble County, Ohio to show other problems associated with mining. Many mining companies leave behind piles of old scrap metal, and as can be seen here, old machinery. Figure 21 is an old abandoned shovel that at one time was used to remove overburden and to load coal. Because of its small size and its age, it was not economical to keep it in repair and use. Figure 22 is of a dragline of considerably larger size than the shovel in figure 21, but it too is small by today's standards of machinery, and due to this and its age, it was left setting with its boom erect and cables still intact. Scenes like this are no longer allowed, because under the new law, mining companies are required to remove or bury any old machinery, scrap metal, or old buildings used during the operation.

Figure 23: Area reclaimed under old law.

Figure 24: Area reclaimed under old law.

Figures 23 and 24 were taken in Muskingum County, Ohio to show that not all mines reclaimed under the old law are bad. Even under the old law some companies took it upon themselves to properly reclaim mines so they would not become waste land. These two areas were mined and reclaimed by the Ohio Power Company, and can hardly be recognized as ever having been strip mines.

Figure 25: Strip mine under new law.

Figure 26: Strip mine under new law.

Figure 27: Strip mine under new law.

Figure 28: Strip mine under new law.

Figures 25 - 26 were taken in Belmont County, Ohio. This area was mined and reclaimed under the new law. The water draining this area had an average pH of 6.55 and an iron content of 0.035 ppm. In figure 25 and figure 26 it can be seen how close the active pit is to reclaimed land. The reclamation follows very close to the mining- only about 200 yards between the highwalls and the reclaimed area are left open. This prevents almost all acid drainage which results from having open pits left for long periods of time. Figures 27 and 28 show the land after being reclaimed, it is in sharp contrast to pits under the old law. No highwalls are present, the area has the same topography as before and due to the replaced topsoil, vegetation is extremely good and uniform.

CONCLUSION

By looking at the results of the soil test of area A, it is obvious that something had to be done to control strip-mine reclamation. Reclamation under the old law was much better than reclamation proir to that time, but still much of the land was left barren. By examining the results of area B it can be seen that the replacement of some topsoil makes a drastic and beneficial difference. In area C with more topsoil replaced and the land returned nearly to original contours, many problems associated with strip-mine reclamation in the past have been alleviated. Due to the replacement of topsoil and the returning the land to the original contours, many areas reclaimed under the new law are just as valuable after mining as before mining, and in some cases more valuable.

In the wake of the 1972 law, the old mine areas can not be overlooked, something has to be done to help restore them. With the complete loss of any topsoil or subsoil from most of these areas and the resulting low pH of the soils, making the soils suitable for plant growth by the addition of lime and fertilizers would be extremely expensive and in most cases completely out of the question. However more research on the soils could be done to study their chemistry in more detail, and then the plants best suited to these areas could be planted. Also research along the lines of developing plants capable of surviving in these areas could be done. Perhaps even city sewage or some such material could be placed on the old mines to retard the oxidation of acid forming materials, and also to produce a medium for plant growth.

After study of the new law and areas affected by it, the author feels that further controls on strip mining and reclamation are not necessary at the present time. Due to the present energy situation and the dependence of electricity generation on strip-mined coal, strictor controls at the present time may not prove to be wise because of the increase in cost. However, if future study in this area shows that more controls are absolutely necessary, they should at that time be applied.

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